NON-PUBLIC?: N
ACCESSION #: 9002080162
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Arkansas Nuclear One, Unit Two PAGE: 1 OF 4

DOCKET NUMBER: 05000368

TITLE: Loose Terminal in a Feedwater Control System Cabinet Resulted in a Reactor Trip Caused be a High Steam Generator Water Level
EVENT DATE: 12/31/89 LER #: 89-024-00 REPORT DATE: 01/13/90

OTHER FACILITIES INVOLVED: Facility Names DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: Dana Millar, Nuclear Safety and Licensing Specialist

TELEPHONE: (501) 964-3100

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On December 31, 1989, a reactor trip occurred from 100% of rated thermal power when 'B' Steam Generator (SG) water level reached a high level setpoint and the Reactor Protective System generated a reactor trip signal. During the transient one of the running condensate pumps which was expected to trip did not trip. Otherwise, the plant responded properly when the reactor trip occurred. The Operations staff responded appropriately and in a timely manner to the reactor trip. Of primary concern was the potential for Reactor Coolant system overcooling or a SG overfill event, however, proper system operation prevented either from occurring. No significant safety concerns were identified. The root cause of this event is believed to be a loose terminal on an electrical module in the 'S' Feedwater Control System (FWCS) cabinet. The terminal was not properly reterminated when maintenance activities were performed

during 2R7 refueling outage. The loose terminal was on an electrical module in the 'S' Main Feedwater (MFW) flow loop to the 'S' FWCS. To verify that the loose terminal could cause a transient similar to this event, simulated signals for 100 percent power conditions for the inputs to the 'B' FWCS were input and the connection on the terminal loosened. A very similar response to the transient which initiated the reactor trip occurred. The loose terminal was properly reterminated. This event is reportable per 10CFR50.73(a)(2)(iv).

A. Plant Status

At the time of occurrence of this event Arkansas Nuclear One, Unit Two (ANO-2) was operating at 100 percent of rated thermal power in Mode 1 (Power Operation). Reactor Coolant System (RCS)AB! pressure was approximately 2250 psig and RCS temperature approximately 580 degrees Fahrenheit.

B. Event Description

On December 31, 1989, at approximately 2145 hours, a reactor trip occurred when 'B' Stem Generator (SG) SG! water level reached a high level setpoint and the Reactor Protective System (RCS)JC! generated a reactor trip signal.

At the initiation of this event, various Control Room annunciators associated with the gain Feedwater (MFW)SJ! system came into alarm. The initial indications appeared to be a loss of 'A' MFW pump SJ-P!. However, the Operations staff quickly verified with Control Room indications that both MFW pumps were running. A few seconds later, the turbine generator lockout relays tripped and the reactor Trip Circuit Breakers (TCBs) opened resulting in a reactor trip.

Upon receipt of a high SG water level signal from 'B' SG, the RPS functioned as designed and generated a reactor trip signal. The Control Room Operations staff performed the immediate actions of the Emergency Operating Procedure (EOP) satisfactorily. At approximately 2249 hours, both heater drain pumps, a part of the Condensate and Feedwater System, and one condensate PLOP were manually secured. There are two condensate pumps powered from each of two 4260 VAC electrical buses. Upon receipt of a signal from the turbine generator lockout relays one condensate pump on each 4160 VAC electrical bus receives a trip signal leaving two condensate pumps running, one on each 4160 VAC electrical bus. The heater drain pumps are designed to trip at a preselected value of pump differential pressure. The pump differential pressure had not yet reached that value when the heater drain pumps were manually

tripped.

As expected, due to normal post trip response, SG water levels decreased to less than twenty-three percent and an Emergency Feedwater Actuation Signal (EFAS) was generated. Initially, only 'A' SG water level decreased to less than twenty-three percent resulting in the EFAS. The EFAS sends an automatic start signal to both Emergency Feedwater (EFW)BA! pumps. ANO-2 has two EFW Pumps, One electric motor driven pump (2P7B) and one steam turbine driven pump (2P7A). Both EFW pumps started automatically and initially provided feedwater to 'A' SG to maintain SG water levels in a predefined operating band. At approximately 2156 hours, 2P7A was secured.

There are two trains of MFW, each of which provides preheated water to each of two SGs. Each train consists of a variable speed steam driven turbine plow and two flow control valves, a win and a bypass feedwater control valve. A Feedwater Control System (FWCS)JB! is designed to control SG downcomer water level. The FWCS receives inputs from MFW flaw, Main Stem (KS)SO! flow and SG downcomer water level. which are combined with analog programs to maintain SG downcomer water level at a predetermined value by sending signals to adjust the MFW pump turbine speed control system or either or both of the M" system flow control valves. During normal steady state operation the FWCS is maintained in an automatic mode of operation. At the time of the reactor trip the FWCS was in an automatic mode of operation.

When the turbine generator lockout relays trip, a preselected V pump trips. The pump which was selected to trip, 'A' NFW pump, tripped satisfactorily. With SG water levels stabilized and EFW available to provide feedwater to both SGs, 'B' NFW pump was secured at approximately 2207 hours. A Reactor Trip Override (RTO) signal within the FWCS functions to automatically reduce NFW flow to the SGs following a reactor trip by fully closing the MFW regulating control valves, closing the MFW regulating bypass control valves to an approximate five percent flow demand position, and decreasing the MFW turbine speed controller to a preset minimum speed. The RTO circuit functioned properly, however, it took approximately fifteen seconds longer for 'B' NFW flow to reach the RTO post trip value than 'A' MFW flow.

In an attempt to determine the cause of the reactor trip, a review of the events which occurred prior to the reactor trip was performed. The review Indicated that the discharge pressure of both MFW pump turbines was increasing, water levels in both SGs were

Increasing and NFW flow was increasing. Approximately six seconds into the transient, 'A' SG water level which was increasing started to decrease. Water level in 'B' SG, however, continued to increase until a high SG water level RPS trip setpoint was reached and a reactor trip signal was generated. It was determined that a malfunction of the FWCS occurred which caused the reactor to trip.

The plant was stabilized in Mode 3 (Hot Standby). A Job Order was issued to troubleshoot the FWCS to attempt to identify the cause of the malfunction.

C. Safety Significance

Upon receipt of the reactor trip signal from the RPS, the plant responded properly. When SG water level reached the preselected trip value for high SG water level, the RPS responded properly and generated a reactor trip signal. The EFW system responded properly when a low SG water level was reached in 'A' SG. There were no major malfunctions of equipment which adversely affected reactor safety. The Operations staff appropriately responded to the reactor trip. The actions of the EOP were completed in a timely manner. The plant was satisfactorily placed in a stable condition (Mode 3) following the reactor trip. Of primary concern was the potential for an RCS overcooling event or a SG overfill event (i.e., water carried over into the Main Steam piping) due to the high water level in 'B' SG. Proper system operation, however, prevented either an RCS overcooling or a SG overfill from occurring. Therefore, it can be concluded that no significant safety concerns existed.

D. Root Cause

The root cause of this event is believed to be a loose connection on a terminal on an electrical module in the 'B' FWCS cabinet. A lug on the terminal was found to be approximately four turns loose. The terminal was not reterminated properly when maintenance activities were performed during 2R7 refueling outage (September 25, 1989 to November 20, 1989). The lug apparently loosened due to vibrations until the terminal and module were no longer in contact, which resulted in the loss of the MFW flow input signal.

The loose terminal was on an electrical module in the 'B' MFW flow loop In the 'B' FWCS. A loss of the MFW flow signal would cause the output demand signal from a waster controller In the 'B' FWCS to increase. With a high output from the master controller, an

Increase in speed for both MFW pump turbines, an increase In demand to 'B' MFW regulating control valve and 'B' MFW regulating bypass control valve would be expected.

The cause of one of the condensate pumps not tripping was determined to be a call switch in the electrical breaker for the 'B' condensate pump motor. The cell switch In the electrical breaker for 'B' condensate pump
motor was out of adjustment causing It to appear to the 'D' pump motor electrical circuitry that 'B' pump was not running. Therefore, 'D' pump remained in operation when the generator lockout relays tripped. Two condensate pumps, 'B' and 'D', powered from the same 4160 VAC electrical bus, were running. By design with 'B' and 'D' condensate pumps running when the generator lockout relays tripped, 'D' condensate pump should have tripped. (If only 'D' condensate pump had been running, it would have remained running.)

E. Basis for Reportability

This event is reportable pursuant to 10CFR50.73(a)(2)(Iv) as an event which resulted in an automatic actuation of an Engineered Safety Features System and the RPS. A four hour report to the NRC Operations Center was made concerning this event in accordance with 50.72(b)(2)(ii) at approximately 2224 hours on December 31, 1989.

F. Corrective Actions

The loose connection found an the terminal of the electrical module in the 'B' FWCS cabinet was reterminated properly. Additionally, other connections In both FWCSs cabinets were inspected and verified to be properly terminated. Complete trouble shooting was performed on both FWCS In an effort to ensure possible causes of the malfunction were identified. The only problem identified was the loose connection on the electrical module in 'B' FWCS. The RTO circuity in 'B' FWCS was tested to verify proper operations. It responded properly and no corrective maintenance was necessary. Several other control systems in which maintenance had been performed during 2R7 were also Inspected for possible loose connections. There were no loose connections identified.

To verify that a loose connection on the electrical module for the MFW flow input could cause a transient similar to this event, simulated signals for 100 percent MFW flow, MS flow and SG downcomer

water level (the inputs to the FWCS) were input into 'B' FWCS with the connection on the electrical module loosened. A very similar response to the transient which initiated the reactor trip occurred. Since no other malfunctions were Identified or loose connections found, it was concluded that the loose connection very likely was the cause of the transient.

The plant procedure which governs maintenance activities was revised on December 22, 1989 to include verification of leads while performing maintenance activities. This should minimize the possibility of events similar to this event from recurring. Training was conducted on this procedure for maintenance personnel prior to implementation.

The cell switch in the electrical breaker for 'B' condensate pump motor was adjusted. The trip sequence logic for 'B' and 'D' condensate pumps was tested and proper operation of the trip logic was verified.

After ANO-2 had returned to power operation, at approximately ninety-one percent of rated thermal power on January 11, 1990, a small perturbation on the FWCS occurred which appeared similar to the original failure. Monitoring instrumentation was connected to the FWCS to closely monitor any unusual perturbations. No similar recurrences have been experienced, however, the FWCS will continue to be closely monitored in an attempt to ensure the system is performing properly.

G. Additional Information

There have been no previously reported events caused by loose wiring connections in the FWCS. Energy Industry Identification System (EIIS) codes are identified in the text as XX!.

ATTACHMENT 1 TO 9002080162 PAGE 1 OF 1

Arkansas Power & Light Company
Arkansas Nuclear One
Route 3, Box 137 G
Russellville, AR 72801
Tel 501 964-3100

January 30, 1990

2CAN019011

U. S. Nuclear Regulatory Commission
Document Control Desk
Mail Station P1-137
Washington, D. C. 20555

SUBJECT: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Licensee Event Report No. 50-368/89-024-00

Gentlemen:

In accordance with 10CFR50.73(a)(2)(iv), attached is the subject report concerning a loose terminal in a Feedwater Control System cabinet which resulted in a reactor trip caused by high steam generator water level.

Very truly yours,

E. C. Ewing
General Manager,
Technical Support
and Assessment

ECE/DM/abw
Attachment
cc: Regional Administrator
Region IV
U. S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76011

INPO Records Center
1500 Circle 75 Parkway
Atlanta, GA 30339-3064

*** END OF DOCUMENT ***